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A STUDY OF THE GREEN PIT-VIPERS OF SOUTHEASTERN ASIA AND MALAYSIA, COMMONLY IDENTIFIED AS *TRIMERESURUS GRAMINEUS* (SHAW), WITH DESCRIPTION OF A NEW SPECIES FROM PENINSULAR INDIA[1]

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This paper is based primarily upon the large number of pit-vipers in the collection of the British Museum (Natural History) and that of The American Museum of Natural History. Its object is to show that no less than five species are commonly identified as *Trimeresurus gramineus* and also to prove that these five species not only are distinct structurally but geographically or ecologically as well.

It has long been known that certain green species of *Trimeresurus* are not readily separated from one another, and a study of the literature makes it evident that all but one of the forms treated here have been more or less understood by previous workers, but it is equally evident that their relationships have never been worked out or set forth by any one herpetologist. The species described as new below has been consistently confused with *gramineus* even though it is not even closely allied to that or any other species dealt with herein.

A study of the hemipenis of nearly every valid species of *Trimeresurus* has convinced us that this genus may be divided into groups of allied forms having different types of hemipenes. A simple key will suffice to show that the six species described in this paper possess no less than three distinct types of structure in this organ. The distribution of each species is given.

[1]Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 115.

A.—Hemipenis relatively short and thick, with numerous, well-developed spines.

1.—Spines present only just distal to point of forking where they extend across the entire width of organ except that part occupied by sulcus. (Upper Burma eastward across southern China and Tongking to Formosa and Hainan)..... *T. stejnegeri.*

2.—Spines distributed from just distal to point of forking nearly as far as tip of organ but always separated from sulcus by a calyculate area. (Peninsular India)..... *T. occidentalis*, n. sp.

B.—Hemipenis long and slender, entirely devoid of spines.

(Upper Burma and southern China southward into the Malay Archipelago to Timor)..... *T. albolabris.*

(Upper Burma southward into the Malay Archipelago).. *T. gramineus.*

(Southern Burma and the Malay Peninsula to the Isthmus of Kra). *T. erythrurus.*

(Malay Peninsula south of the Isthmus of Kra)..... *T. purpureomaculatus.*

The hemipenis at best is a difficult character because it is useless when females and very young examples are in question. It is, therefore, deemed wise to give a key based upon more usual characters even though such a key fails to show true relationships so well and must depend in part upon geographical data.

A.—Scales smooth or with barest trace of keel on some mid-dorsal rows. *T. occidentalis*, n. sp.

B.—Scales keeled.

1.—First upper labial entirely separated from nasal by a suture.

Distributed from Upper Burma eastward across southern China and Tongking to Formosa and Hainan..... *T. stejnegeri.*

Distributed from Upper Burma southward into the Malay Archipelago. *T. gramineus.*

2.—First upper labial entirely or partly united to nasal.

a.—Dorsal head scales granular; temporals and scales adjacent to posterior upper labials distinctly keeled.

aa.—Color uniform dark brown to blackish, or green with dark blotches above; usually 19 or more rows of scales just before vent.. *T. purpureomaculatus.*

bb.—Uniform light green above and below; usually 17 or less scale rows just before vent.. *T. erythrurus.*

b.—Dorsal head scales not granular; temporals smooth or weakly keeled; scales between temporals and posterior upper labials smooth..... *T. albolabris.*

As recently as 1927, Stejneger attempted to settle the question of the relationship and distribution of the Chinese species of the pit-vipers considered here but he was not successful because he did not realize that more than two forms were involved. In fact, nothing short of a close comparison of types with large series of the various species would have permitted anyone to solve a part or the whole of this difficult problem.

We have tried to present data that will enable others to separate the various species involved and, while doing so, check our conclusions. Further study of the literature is costly in time and of little value because the diagnostic characters are rarely given. We have noticed many minor differences that will, we believe, when studied more fully, serve as good subspecific characters. This applies chiefly to the more widespread forms. The question of subspecific division is left entirely to the future and not even discussed here.

Before giving detailed descriptions we wish to emphasize what has already been indicated: i.e., the extreme difficulty of the problem involved. When we first discovered the striking differences between the hemipenes of *stejnegeri* and *gramineus*, in spite of a marked similarity in external form, Dr. Malcolm Smith suggested that perhaps the hemipenis itself is very variable. In order to check this point, we examined and tabulated data on the hemipenes of large numbers of males from widely separated localities and found the amount of variation to be very little.

One question of general interest is raised by the present study: i.e., is the hemipenis more or less stable than the various external scale characters generally relied upon for the determination of species and even genera? Also, is it more valuable for the separation of large or small groups in the classification of snakes? In the genus *Trimeresurus*, the hemipenis is excellent for the separation of the various species into groups, but we think it would be dangerous to generalize until more detailed data on this organ in other genera are available.

The descriptions have been written to serve as a model for future descriptions of all species of *Trimeresurus*, not merely to enable one to distinguish the forms treated herein.

We wish to thank Mr. H. W. Parker of the British Museum for the generous way in which he put the material under his care at our disposal.

Trimeresurus occidentalis, new species

Lachesis gramineus BOULENGER, 1896, 'Cat. Snakes Brit. Mus.,' III, p. 554 (part).

TYPE.—British Museum Register No. 82.8.26.40; ♂, not fully mature; Mudmalley, Wynad, southwestern India; Beddome, collector.

DESCRIPTION OF TYPE.—Rostral three times as broad at base as at tip and much broader at base than high. Internasals broad, only slightly elongate, separated by a scale half the size of each internasal, a little larger than largest adjacent head scales. Nasals not constricted in middle, undivided, not concave, completely separated from first upper labial on one side, two-thirds separated on other. Second upper labial

high, forming anterior border of pit. Upper part of second upper labial separated from nasal by two small scales and some bare skin on one side, one very small scale and bare skin on other. Two scales of nearly equal length on a line between eye and nasal, anterior one forming upper angle of canthus rostralis. Supraoculars a little longer than horizontal diameter of eye; as broad as average anterior head scale and extending backward a little farther than posterior margin of orbit. Inner margins of supraoculars unbroken by sutures and separated by eight to nine head scales. Internasals separated from supraoculars by two scales, neither of which differs markedly in size or shape from other anterior head scales. Upper head scales smooth, irregular, medium in size posteriorly, noticeably increasing in size anterior to eyes. The center of line connecting anterior extremities of supraoculars is separated from scale between internasals by two scales. Two postoculars on each side; suboculars separated from upper labials by one scale on each side. Temporal scales smooth, not noticeably enlarged. Pupil vertical. Eye separated from labial border by distance equal to its horizontal diameter and from tip of snout by a distance two and one-half times this diameter. Upper labials 9–9. Lower labials 10–10, first pair in contact behind symphysial. Chin shields regular, first pair slightly enlarged. Scales generally smooth but with bare trace of obtuse keel sometimes discernible. Anteriorly, middorsal scales are long, narrow, convex and not imbricate; while posteriorly they are slightly longer, three times as broad, flat and slightly imbricate. Scale rows 21–19–17–15; reduction by loss of 5th row occurring approximately opposite 60th, 50th, and 29-34th ventral plates, respectively, counting forward from anal; first count taken one head-length behind head. Ventrals 154. Anal entire. Caudals 60, divided. Snout to vent 230 mm. Tail 99 mm.

Hemipenis moderate in length, extending to 8–9th caudal plate, forked opposite the 3d plate. Sulcus bordered on either side by a broad calyculate area extending to tip of organ. Numerous spines present from a point just distal to forking to or nearly to tip. Many spines well developed, the largest with free end 1½ mm. in length.

Color uniform green above; yellowish white beneath, the latter color extending on to the first row of scales anteriorly, and on to the upper lip to the horizontal level of the lower margin of the eye.

There are five paratypes in the British Museum as follows:

2 ♂; Matheran, east of Bombay City; ventrals 174 and 175; caudals 71 and 70+

♂; Bramagherries, southwestern Peninsular India; ventrals 145; caudals 55

♀; "Cuddapa Hills," eastern Peninsular India, about 14° N. lat.; ventrals 177; caudals 59

♀; Shevaroys, eastern Peninsular India, about 12° N. lat.; ventrals 171; caudals 58

The scale formula is uniformly 21–19–17–15. The supraoculars are entire except that in one specimen each is nearly divided into two by a suture. The internasals are always well separated by two or three scales or else one large scale partly divided, while the first upper labial is completely cut off from the nasal on both sides. Small scales are uniformly present between the nasal and the part of the second upper labial forming the anterior border of the pit.

DISCUSSION.—This new form may be compared to *anamallensis* and *strigatus* from Peninsular India as follows: in *T. strigatus* the second

upper labial is distinct from the scale forming the anterior border of the pit, while in *occidentalis* these scales are united; moreover, *strigatus* has a complicated blotched pattern in browns, while the new form is uniform green above with a trace of pattern evident in the young. In *T. anamallensis*, an ally of the new form, the supraoculars are nearly always divided, the scales, including those of the temporal region, distinctly keeled, and the dorsum with varying amounts of black pigment, especially evident on the tail where it takes the form of complete rings. In contrast to this, *T. occidentalis* rarely (if ever) has divided supraoculars. Its scales are never keeled in the temporal region and only slightly so along the middle of the back, while, as already stated, it is almost devoid of pattern.

T. occidentalis has long been confused with *gramineus* auct. which proves, however, to include at least four species, some of them not even closely allied to one another as shown by their distinctive types of hemipenes. The form here described may be separated from all others long included with it under *gramineus* not only by its characteristic hemipenis but by its geographical isolation as well.

It is significant to note that Wall[1] (pp. 49–50) writes of "*T. gramineus*" as follows: "It is found in the Eastern Ghats, Western Ghats, Nilgiris and other hills in the Peninsula of India. It does not occur in the plains of India, but affects an altitude of from 1500 to 6000 feet. East of Calcutta it occurs in the plains and hills alike." Here we have good evidence that *occidentalis* exhibits a definite habitat preference and that no plateau or plain form of *gramineus*, such as *albolabris*, is found in Peninsular India. Wall's "it," following the phrase, "East of Calcutta," obviously does not refer to *occidentalis*.

Trimeresurus stejnegeri Schmidt

Trimeresurus stejnegeri Schmidt, 1925, Amer. Mus. Novitates, No. 157, p. 4 (type locality, Shaowu, Fukien, China).

Trimeresurus yunnanensis Schmidt, *loc. cit.* (type locality, Tengyueh, Yunnan, China).

Trimeresurus gramineus stejnegeri Stejneger, 1927, Proc. U. S. Nat. Mus., LXXII, Art. 19, p. 9.

Trimeresurus gramineus stejnegeri Pope, 1929, Bull. Amer. Mus. Nat. Hist., LVIII, p. 478.

The type may be described in more detail as follows:

Adult Male.—A. M. N. H. No. 21054; Shaowu, N. W. Fukien, China; Andrews and Heller, collectors.

[1]Wall, F. 1928. 'The Poisonous Terrestrial Snakes of our British Indian Dominions (including Ceylon) and How to Recognize them, with Symptoms of Snake Poisoning and Treatment.' Bombay.

Rostral two and one-half times as broad at base as at tip and much broader at base than high. Internasals indistinct, not or barely elongate; separated by four scales about size of internasals. Nasal not constricted in middle, not divided, not concave, completely separated from first upper labial on both sides; second upper labial high, forming anterior border of pit. Upper part of second upper labial separated from nasal by one medium-sized scale on one side, in contact with nasal on other. Two scales on a line between eye and nasal, posterior one a little deeper and longer; anterior one forming upper edge of canthus rostralis, which is distinctly projecting. Supraoculars narrow, with slightly irregular inner margins and separated from one another by twelve head scales; one supraocular divided anteriorly. Internasals separated from supraoculars by four scales on each side, no one of which differs markedly in size or shape from other anterior head scales. Upper head scales medium and fairly regular in size, not noticeably enlarged anteriorly; smooth. The center of line connecting anterior extremities of supraoculars is separated from scale between internasals by four to five scales. Postoculars 2–3; suboculars separated from upper labials by two scales on each side. Temporal scales not or only slightly enlarged, smooth. Pupil subelliptical. Eye separated from labial border by a distance equal to its horizontal diameter and from tip of snout by two and a half times this diameter. Upper labials 10–11. Lower labials 13–12, first pair in contact behind symphysial. Chin shields irregular, first pair enlarged. Anteriorly, mid-dorsal scales are about half as broad as they are posteriorly. With the exception of outer row on each side, scales are distinctly but obtusely keeled throughout, the keel traversing entire length of scale except on neck. Scale rows 21–19–17–15; reduction by loss of fifth[1] row occurring approximately opposite 63d, 53d[1] and 45th ventral plates, respectively, counted forward from anal; first count taken one head-length behind head. Ventrals 165. Anal entire. Caudals 62, divided. Snout to vent 577 mm. Tail 111 mm.

Color uniform green above, somewhat lighter green below. A narrow, yellowish lateral stripe along the middle of the first scale row; this stripe stops on neck anteriorly and a little beyond vent posteriorly. Tip of tail pale reddish. Head without pattern or postocular stripe.

The hemipenis of A. M. N. H. No. 33225 from Chungan Hsien, northwestern Fukien, is short and thick, extending to 13–14th caudal plate, forked opposite 7–8th; spinous basally, calyculate distally. Twelve to thirteen large spines, first five very large, nearly equal in size and extending across entire width of organ; rest of spines gradually decreasing in size; numerous minute spines proximal to large spines. Lips of sulcus devoid of spines and not prominent. Calyces without scalloped edges.

The following specimens in the British Museum were examined:

♂; Kuatun, Fukien, China; ventrals 168; caudals 69; scales 21–21–14[2]
♂; Near Ningpo, China; ventrals 169; caudals 70; scales 23–21–15
5♂; Formosa; ventrals 162, 162, 155, 158, 162; caudals 70, 68, 69, 67, 69; scales 21–21–15 for all five
♂; Mogok, Upper Burma; ventrals 159; caudals 65; scales 21-19-15
♂; Himalayas; ventrals 155; caudals 64; scales 21–19–15
♂; Sikkim Himalayas; ventrals 157; caudals 58 (+?); scales 21–19–14 (13)
♂; Shillong, Khasi Hills, Assam; ventrals 158; caudals 64; scales 21–21–15

[1]The preservation of the type renders a determination of the point at which the second reduction occurs most difficult. It is also hard to see which row is involved.
[2]Counted a head-length behind head, at midbody, and just before vent.

Trimeresurus gramineus (Shaw)

Coluber gramineus Shaw, 1802, 'Gen. Zool.,' III, part 2, p. 420 (type locality, Vizagapatam, India; based on Russell's 'Ind. Serp.,' I, Pl. ix.)

Trimeresurus gramineus Guenther, 1864, 'Reptiles Brit. India,' p. 385, figs. (part).

Lachesis gramineus Boulenger, 1896, 'Cat. Snakes Brit. Mus.,' III, p. 554 (part).

A typical specimen of *gramineus* may be described in detail as follows:

Adult Male.—British Museum Register No. 72.4.17.137; Khasi Hills, Assam; Jerdon, collector.

Rostral nearly three times as broad at base as at tip and much broader at base than high. Internasals distinct, elongate; separated by a scale one-half size of each internasal. Nasal not constricted in middle, not divided, not concave, completely separated from first upper labial on both sides; second upper labial high, forming anterior border of pit. Upper part of second upper labial separated from nasal by two large scales on either side. Two scales on a line between eye and nasal, posterior one a little deeper and longer; anterior one forming upper edge of canthus rostralis which is distinctly projecting. Supraoculars narrow, with irregular inner margins; broken up posteriorly into small scales and separated from one another by thirteen to fourteen head scales. Internasals separated from supraoculars by four scales on each side, no one of which differs markedly in size or shape from other anterior head scales. Upper head scales medium and fairly regular in size, not noticeably enlarged anteriorly; keeled posteriorly and in temporal regions. The center of line connecting anterior extremities of supraoculars is separated from scale between internasals by four to five scales. Suboculars separated from upper labials by two scales on each side. Temporal scales not noticeably enlarged. Pupil vertical. Eye separated from labial border by a distance equal to its horizontal diameter and from tip of snout by a little more than twice this diameter. Upper labials 9–10. Lower labials 12–12; first pair in contact behind symphysial. Chin shields regular, first pair enlarged. Anteriorly, mid-dorsal scales are about one-third as broad as they are posteriorly. With the exception of outer row on either side, scales are distinctly but obtusely keeled throughout, keel traversing entire length of scale except on sides of neck. Scale rows 23–21–19–17–15; reduction by loss of 5th row occurring approximately opposite 142d, 58th, 50th and 38th ventral plates, respectively, counting forward from anal; first count taken one head-length behind head. Ventrals 165. Anal entire. Caudals 70, divided. Snout to vent 758 mm. Tail 167 mm.

Hemipenis long and slender, extending to 25–26th caudal plate, forked opposite 7–8th plate. Entirely devoid of spines. Calyculate from tip of organ nearly to point of forking. Proximal to this, longitudinally folded. Sulcus prominent throughout.

Color uniform green above; lighter green below. First row of scales on each side brown with yellow tip, second row yellow below keel. The narrow bichromate lateral stripe thus formed ending just behind head anteriorly and at vent posteriorly, incompletely developed on tail. Tip of tail pale reddish. Head without pattern or postocular stripe.

The following specimens were examined in the British Museum:

♂; Darjeeling, Bengal; ventrals 166; caudals 56+; scales 21–21–15
♂; Mergui, Tenasserim; ventrals 161; caudals 71; scales 21–21–15
♀, 3♂; Prov. Wellesley, Malay Peninsula; ventrals 164, 163, 161, 168; caudals 58, 74, 75, 72; scales uniformly 23–21–15
♀, ♂; Pinang, Malay Peninsula; ventrals 165, 163; caudals 61, 75; scales 23–19–15, 21–21–15
♂; "Sungei, Kumbang, Korinchi," Sumatra, 4700 ft.; ventrals 146; caudals 64; scales 21–19–15
♀, ♂; "Lao Mts., Cochin-China"; ventrals 168, 164; caudals 62, 73; scales 21–21–15, 23–21–17
♂; Saiap, Kina Balu, Borneo; ventrals 155; caudals 74; scales 21–21–15

Trimeresurus erythrurus (Cantor)

Trigonocephalus erythrurus Cantor, 1839, Proc. Zool. Soc. London, p. 31 (type locality, Ganges Delta).

Trimeresurus erythrurus Guenther, 1864, 'Reptiles Brit. India,' p. 386 (part).

Lachesis gramineus Boulenger, 1896, 'Cat. Snakes Brit. Mus.,' III, p. 554 (part).

The type may be described in more detail as follows:

Immature Male.—British Museum Register No. 94.6.25.15; Ganges Delta; Cantor, collector.

Rostral one and one-half times as broad at base as at tip and much broader than high. Internasals broad, only slightly elongate, broadly in contact, much larger than adjacent head scales. Nasal not constricted in middle, not divided, not concave; save for very short suture (on both sides) in posterior margin, united with first upper labial. Second upper labial high, forming anterior border of pit. Upper part of second upper labial slightly separated from nasal by a minute scale on either side. Two scales on a line between eye and nasal, anterior one a little shorter, forming slightly projecting upper angle of canthus rostralis. Supraoculars a little longer than horizontal diameter of eye; twice as broad as average mesial head scales and extending backward about as far as posterior margin of orbit. Inner margins of supraoculars unbroken by sutures and separated by thirteen to fifteen head scales. Internasals separated from supraoculars by four scales; first twice as big as average anterior head scales, others agreeing with these in size and shape. Upper head scales granular, moderately irregular, small in size. The center of line connecting anterior extremities of supraoculars is separated from internasals by five scales. Two postoculars on each side; suboculars separated from upper labials by one scale on each side. Temporal scales distinctly but bluntly keeled, somewhat enlarged. Pupil vertical. Eye separated from labial border by distance equal to its vertical diameter and from tip of snout by a distance slightly greater than twice this diameter. Upper labials 9–10. Lower labials 12–12, first pair in contact behind symphysial. Chin shields regular; first two pairs enlarged. Mid-dorsal scales scarcely twice as wide posteriorly as anteriorly. With the exception of outer row, scales are distinctly but obtusely keeled throughout, keel traversing entire length of scale except on sides of neck. Scale formula[1] irregular but

[1]The bad condition of the type makes an exact determination impossible.

approximately 21–23–21–19–17–15, the reduction from 21 to 15 taking place on the posterior half of the body. Ventrals 174. Anal entire. Caudals 67, divided. Snout to vent 395 mm. Tail 73 mm.

Color uniform green above; lighter green below. Scales of first row with yellow center, the resulting stripe extending from just behind head to vent, beyond which it shifts to tips of subcaudals and soon disappears. Tip of tail greenish brown, incompletely banded with dark brown. Upper lip lighter than top of head; no postocular stripe.

The type is a female and the hemipenis of the largest male is immature. The organ, however, is long and slender, devoid of spines and has a prominent sulcus. No further details can be ascertained but it may safely be concluded that the hemipenis is of the same general type as that found in *albolabris*, *gramineus*, and *purpureomaculatus*.

The scale formula of the type being irregular and difficult to determine, that of the specimen from Pegu is given here. Complete formula 25–23–21–19–17. From a point a head-length behind the head to approximately opposite the 60th ventral plate, counted forward from the vent, the scales are in twenty-five rows. From this point reductions follow in rapid succession until a minimum number of 17 is reached near the 20th plate.

The following specimens in the British Museum were examined:

♀, ♂; Burma; ventrals 161, 164; caudals 44+, 79; scales 23–23–15, 23–23–16
♀; Toungoo, Lower Burma; ventrals 162; caudals 52; scales 25–25–17
♀; Pegu, Lower Burma; ventrals 161; caudals 56; scales 25–25–17
2 ♀, ♂; Rangoon, Lower Burma; ventrals 171, 165, 163; caudals, 58, 59, 66; scales 25–23–17, 25 (26)–25–17 (18), 23–23–17
♀; Moulmein, Lower Burma; ventrals 158; caudals 55; scales 21–21–15

Trimeresurus albolabris Gray

Trimeresurus albolabris Gray, 1842, 'Zool. Misc.,' p. 48 (type locality, China).

Lachesis gramineus Boulenger, 1896, 'Cat. Snakes Brit. Mus.,' III, p. 554 (part).

One of the types may be described in more detail as follows:

Half-grown Female.—British Museum Register No. 1.2.2.*a*; China; Reeves, collector.

Rostral twice as broad at base as at tip, a little broader than high. Internasals broad, elongate, broadly in contact, much larger than adjacent head scales. Nasal not constricted in middle, undivided, not concave, each nasal half separated from its first upper labial by two sutures. Second upper labial high, forming anterior border of pit. Upper part of second upper labial in contact with nasal on both sides. Two scales on a line between eye and nasal, the anterior much the shorter and forming upper angle of canthus rostralis. Supraoculars much longer than horizontal diameter of eye, as broad as largest anterior head scales, and extending backward as far as posterior margin of orbit. Inner margins of supraoculars scarcely broken by sutures, separated by ten to twelve scales. Internasals separated from supraoculars by three scales on one side, four on other, no one of which differs markedly in size or shape from other anterior head scales. Upper head scales smooth, irregular, scarcely increasing

in size anteriorly. Center of line connecting anterior extremities of supraoculars is separated from internasals by four scales. Two postoculars on each side. Suboculars separated from upper labials by one scale on each side. Temporal scales smooth, scarcely enlarged. Pupil vertical. Eye separated from labial border by distance equal to nearly twice its vertical diameter and from tip of snout by three times this diameter. Upper labials 10–11. Lower labials 12–13, first pair in contact behind symphysial. Chin shields regular, first pair somewhat enlarged. All but first two or three outer rows of scales obtusely keeled.[1] Anteriorly, mid-dorsal scales about half as wide as posteriorly. Scale rows 21–19–17–15, the reduction from 21 to 19 taking place somewhere posterior to 70th ventral plate counting forward from anal. Ventrals 152. Anal entire. Caudals 49, divided. Snout to vent approximately 435 mm. Tail 75 mm.

Color uniform green above; yellowish white below. Each scale of first row with light center, the resulting stripe extending from neck, where it is somewhat widened, to vent. On tail, it is present laterally on subcaudals, but soon disappears. The yellowish white color of belly is present on upper lip to horizontal level of lower margin of eye. No postocular stripe. Tip of tail pale reddish.

The hemipenis of the other type is very long and slender, entirely devoid of spines, extending to 21st caudal plate, forked opposite 5–6th plate. Finely calyculate from tip of organ nearly to point of forking. Lips of sulcus prominent throughout.

The following specimens were examined in the British Museum:

(Type) ♂; China; ventrals 156; caudals 62; scales 23–21–15
♀, ♂; Hongkong; ventrals 163, 159; caudals 53, 69; scales 21–21–15, 23–21–15
2♂; Formosa; ventrals 154, 149; caudals 65, 62; scales 21–21–15, 23–21–15
♂; Darjeeling, Bengal; ventrals 164; caudals 64; scales 21–21–15
♀; Dibrugarh, Assam; ventrals 168; caudals 56; scales 23–21–15
♀; Mogok, Upper Burma; ventrals 161; caudals 53; scales 23–21–17
♂; Tounggyi, S. Shan States, Burma; ventrals 165; caudals 65; scales 21–21–15
♀; Moulmein, Lower Burma; ventrals 167; caudals 55; scales 21–21–15
2♀; Siam; ventrals 164, 158; caudals 57, 40(+?); scales 20–21–15, 21–21–15
♂; Kontum, Annam; ventrals 166; caudals 72; scales 21–21–15
♂; Sumatra; ventrals 162; caudals 73; scales 21–21–15
3♀, 3♂; Java; ventrals 159, 165, 170, 161, 165, 164; caudals 60, 54, 62, 73, 71, 75; scales 23–21–15, 21–21–15, 21–21–15, 21–21–15, 21–21–15, 21–21–14
♀, ♂; Lombok; ventrals 162, 166; caudals 57, 74+; scales 21–21–15, 21–21–15
♂; Sumba; ventrals 160; caudals 72; scales 20–21–15
♀; Flores; ventrals 164; caudals 57; scales 21–21–15
♂; Ombaya, Allor; ventrals 163; caudals 71; scales 21–21–15
♀; Timor; ventrals 164; caudals 58; scales 21–21–15
2♀; Kupang, Timor; ventrals 165, 166; caudals 56, 57; scales 21–21–15, 21–21–15

[1]The bad condition of this snake posteriorly makes the determination of this character as well as the exact scale formula extremely difficult.

Trimeresurus purpureomaculatus (Gray)

Trigonocephalus purpureomaculatus GRAY, 1834, 'Ill. Ind. Zool.,' I, Pl. LXXXI (type locality, Singapore).

Lachesis purpureomaculatus BOULENGER, 1896, 'Cat. Snakes Brit. Mus.,' III, p. 553 (part).

The type may be described in more detail as follows:

ADULT FEMALE.—British Museum Register No. 1.2.4.*a*; Singapore; Hardwicke, collector.

Rostral a little less than twice as broad at base as at tip, much broader than high. Internasals reduced, scarcely twice as large as adjacent head scales, barely elongate; separated by two scales, each about size of internasals. Nasal not constricted in middle, undivided, not concave, almost completely united with first upper labial, there being no dividing suture in front and only the trace of one behind. Second upper labial high, forming anterior border of pit. Upper part of second upper labial separated from nasal by one small scale on either side. Three scales on a line from eye to nasal, first largest, second smallest; anterior one forming upper edge of canthus rostralis which is scarcely concave. One supraocular as long as vertical diameter of eye, the other extended forward and longer than this diameter; as broad as average anterior head scales; extending backward about to posterior margin of orbit. Inner margins of supraoculars unbroken by sutures and separated by sixteen head scales. Internasals separated from supraoculars by six scales on one side and eight on the other, none of which differs markedly in size or shape from adjacent head scales. Upper head scales small, granular, uniform in size. The center of line connecting anterior extremities of supraoculars is separated from scales between internasals by eight scales. Three postoculars on one side, one on the other; suboculars separated from upper labials by three rows of scales on either side. Head scales, including temporals and those adjacent to upper labials, bluntly but distinctly keeled. Pupil vertical. Eye separated from labial border by twice its vertical diameter and from tip of snout by nearly three times its horizontal diameter. Upper labials 11–11. Lower labials 15–15, first pair in contact behind symphysial. Chin shields regular, first pair greatly enlarged. Mid-dorsal scales twice as broad posteriorly as anteriorly. With the exception of outer row, scales are distinctly but obtusely keeled throughout, keel traversing entire length of scale except on sides of neck. Scales in twenty-seven rows, one head-length behind head, in nineteen just before vent, abnormal along most of body.[1] Ventrals 163. Anal entire. Caudals 59, divided. Snout to vent 818 mm. Tail 147 mm.

Color uniform dark brown above and lighter brown beneath; lower part of first row of scales same color as belly, forming a faint lateral stripe which is set off from the belly by the darkened tips of the ventral plates.

The type being a female, the following description of the hemipenis is based on a male from the type locality. Hemipenis very long and slender, entirely devoid of spines, extending to 20th subcaudal plate; forked opposite 3d plate; finely calyculate from tip of organ nearly to point of forking. Lips of sulcus very prominent throughout and calyculate.

The squamation of another example from the type locality is described here because, as already stated, the type is abnormal. From a point one and one-half head-

[1]See page 12 for scale formula of a normal individual.

lengths posterior to head, the complete formula is 27–29–27–25–23–21–19. The increase from 27 to 29 takes place approximately opposite 114th ventral plate counted forward from vent, and 29 rows are maintained until opposite 66th plate. Posterior to this, reductions follow one another in rapid succession and the minimum count of 19 is reached about opposite 18th plate from vent.

The following specimens in the British Museum were examined:

♀, 2 ♂; Singapore; ventrals 165, 163, 163; caudals 64, 77, 76; scales 27–29–19, 27–25–19, 28–25–19

Juv. ♀, juv. ♂; Straits of Johore, southern Malay Peninsula; ventrals 166, 167; caudals 60, 73; scales 27(about)–27–19, 27–26–19

2 ♀; Pinang, Malay Peninsula; ventrals 165, 170; caudals 57, 63; scales 27–27–19 in both

♀; Puket, Peninsular Siam; ventrals 170; caudals 69; scales 27–26–20

♀; Yumeekee, Mergui, Tenasserim; ventrals 171; caudals 58+; scales 26–25–17

♂; Dinding Ids., Malay Peninsula; ventrals 168; caudals 60+; scales 27–27–19

♂; "India"; ventrals 161; caudals 74; scales 27–25–19

CONCLUSIONS

1.—The snakes commonly identified as *Trimeresurus gramineus* represent several species, some of them not even closely allied. Two of them, *T. stejnegeri* and *T. albolabris*, have been clearly recognized as distinct forms by Mell, Stejneger, Schmidt, C. H. Pope, and others, while one, *T. occidentalis*, is described here as new, having never before been recognized in print as a valid form. It is not even closely allied to any of the species treated in this paper.

2.—In defining the species and groups of species of *Trimeresurus*, the hemipenis is of great importance.

3.—After the hemipenis, the scutellation of the head is most important, while that of the body is of little significance. In the species considered in this paper, the following scale characters are most diagnostic:

a).—Shape and size of internasals and presence or absence of scales between them.

b).—Relation of first upper labial to nasal.

c).—Presence or absence of scales between the upper part of the second upper labial and the nasal.

In the past, sufficient weight has never been placed upon these primary characters.

4.—Female *T. gramineus* and *T. stejnegeri* cannot be distinguished from each other with certainty, while mature males are recognized at once by the form of the hemipenis. Immature males generally may be separated by color characters. The meaning of this external similarity in two forms with radically different hemipenes is not understood but may be correlated with ecological adaptations. Therefore, field studies are much needed.

5.—The value of the hemipenis in the classification of snakes calls for further investigation as it is by no means clearly understood.